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ENGAGING STAKEHOLDERS IN NON-STRUCTURAL RISK COMMUNICATION AND MITIGATION

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ABSTRACT

The KnowRISK project addresses two challenges. The first one is to express scientific/technical information in a form and language that can be understood by audiences with different background, education, and awareness of seismic risk. The other challenge is to ensure that the information is available to as many as possible of those in need, even those who are not aware of the need. The solution to the first challenge is to provide communication tools tailored to the needs of the audience. The solution to the second challenge is to engage stakeholders in the preparation and dissemination of the communication tools. This paper summarizes stakeholder engagement actions taken in the KnowRISK project. These actions were organized in the form of semi-structured interviews, focus groups, and, in the case of schools, direct intervention in classes. The emphasis of the interviews and focus groups was to understand the needs, beliefs, priorities, and obstacles of different stakeholders involved in reducing seismic risk due to non-structural damage. The stakeholders included common citizens, scientists and engineers, teachers, business owners, facility managers, politicians, and local authorities. Information collected from the interviews and focus groups were qualitatively analyzed, for example, using thematic discourse analysis in some pilot areas with different awareness to seismic risk. Moreover, the information was used to validate and supplement ranking of priorities of actions for risk mitigation, developed ex ante in the project. The inputs from the stakeholders were incorporated in the communication tools. The experience from KowRISK shows that engagement of stakeholders is not only feasible but also rewarding.

Keywords: Risk communication; Stakeholders engagements; Non-structural elements; Costs-Benefit Analysis; Thematic discourse analysis

1. INTRODUCTION

Seismic risk is a threat to people and sustainable development in many European regions. To reduce risk posed by natural hazards, reducing vulnerability of population and infrastructure is certainly the

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most efficient and beneficial human action. The European Union and its Member States invest in research in the fields of earthquake engineering and seismology to facilitate development of codes and practices of seismic resistant design and retrofit. In addition, research and dissemination action aimed at Civil Protection is of great interest. However, knowledge and research, on their own, do not yield a direct reduction of vulnerability. The practical application of accumulated knowledge, including technical tools, leads to reduction of seismic vulnerability and, therefore, seismic risk. It requires the involvement of a large array of stakeholders, including government authorities, private companies, contractors, building sector professionals, community organizations, educational sector, and citizens.

An important part of seismic risk is associated with non-structural elements (NSE). Although often disregarded, these elements may cause large economic losses, injures and, even deaths. If vulnerability of non-structural elements of the buildings is not properly considered, even structurally robust and stable buildings pose risk. Structural deformation and acceleration are responsible for triggering non-structural damage. Mitigation of non-structural risk is not so costly and technically difficult as structural retrofitting. Risk awareness and information of mitigation measures are essential for risk reduction.

The KnowRISK project is funded by the European Commission to address the challenge of transferring technical knowledge on non-structural seismic risk mitigation to stakeholders and communities at risk. The project actions are implemented in the three countries of the KnowRISK consortium: Portugal, Italy and Iceland. The city of Lisbon in Portugal, villages around Mt Etna Volcano and other localities in northern Italy, and South Iceland Lowland are the pilot areas of this project.

Seismic risk communication is often tackled in a well-intended but also surprisingly haphazard manner (Morgan et al., 2002). Communication often fails when scientific experts lack systematic knowledge of target-group needs, beliefs and opinions, and use inappropriate terminology for communication (Bruine and Bostrom, 2012). Needs of target-group knowledge are also required when risk communication seek to follow a prioritizing approach, ranking mitigation actions. Under KnowRISK, formulated and implemented stakeholder engagement framework was devised to enhance knowledge of target groups and to learn about their needs, concerns, and beliefs.

This paper presents this framework and the results of risk communication with communities and stakeholders. The methodology is mainly based on interviews and focus groups. This approach was useful in preparing and validating risk communication tools. Although not suitable for generalization, the methods and results of this engagement can provide important insights on ‘giving voice’ to the stakeholders, in terms of giving importance to their views, and involving them in risk communication and mitigation actions.

2. THE METHOD

The risk communication methodology followed under KnowRISK project comprehends: (i) the selection and diagnosis of pilot-areas in terms of seismic history, level of hazard, its prevalence and the related vulnerability; (ii) the selection of relevant stakeholders; and (iii) a multi-method approach to monitor the impacts of communication among target-groups.

The assessment of needs-obstacles-priorities of local communities and selected stakeholders followed a qualitative action-research strategy. This is a type of strategy that puts emphasis on dialoque (Bryman, 2005) and is adopted when the researcher has great interest on comprehending the interviewee's point of view. Compared to quantitative inquiry techniques, qualitative techniques are more flexible. For example, individual or group interviews provide more opportunities for the researcher to go deeper on certain subjects or to introduce new questions that follow up interviewee's replies (Bryman, 2005). Although the methodology is based on dialogue, its form and platform was different in the diverse pilot areas. In Portugal, stakeholders' point of view was approached through individual semi-structured interviews. Italy adopted a mix of individuals' interviewing techniques and focus groups. In Iceland, the dialogue was organized in the form of a session of interaction among experts and stakeholders.

The KnowRISK main objectives of interaction with stakeholders are:

a) to know the views of a set of stakeholders and community members about earthquake risk, seismic protection and non-structural vulnerability;

b) to prepare and validate KnowRISK supportive risk communication materials considering stakeholders' views and needs;

c) to foster knowledge and awareness about non-structural risk mitigation.

As regard to KnowRISK communication, two tools are relevant. The first one is the Practical Guide (PG) (Ferreira et al., 2018) prepared for citizens, and the second is the Portfolio of Solutions (Ferreira et al., 2018) prepared for professionals. This paper describes the contribution of stakeholders for these communication tools.

Stakeholders were selected on the basis purposive sampling procedures. This is a common strategy in qualitative action-research approaches where the researcher proceeds with a selection of people to interview on the basis of research aims and questions. In this type of procedure statistical representativeness and generalization are clearly impossible. As such, it is not even an issue since what the researcher looks for is to create opportunities to go deeper on a certain topics with interviewees and become aware of all the details and personal views independently of the number of times they are referred by the researcher.

In the following sections, a brief characterization of KnowRISK pilot-areas will be pursued jointly with a more detailed description of adopted qualitative interviewing techniques.

2.1. Pilot-areas

The KnowRISK pilot areas differ in terms of earthquake recurrence, exposure to hazard, experience from recent earthquakes, and vulnerability of citizens and infrastructure.

In Continental Portugal , the latest seismic experience dates back to the 1969 Mw 7.5 earthquake that occurred on the Azores-Gibraltar seismic belt, about 230 km SW of Lisbon. There were very few victims and most of the economic losses in Lisbon was due to non-structural damage.

In Italy, damaging earthquakes have been frequent in the recent years. The most recent ones are the 2016 Amatrice-Visso-Norcia sequence (M_W 6.0, 5.9, 6.5) in Central Italy and the 2012 Emilia sequence (M_w 5.9 and 5.8) in Northern Italy. In the worst hit areas, building collapse has been common, and structural damage is extensive. The 2012 Emilia, however, caused mostly non-structural damage in an area where the population was not aware of seismic risk.

Recurring strong earthquakes (since 2000: M_w 6.5, 6.5 and 6.3) in Iceland have contributed to a high level of awareness in the local communities (Bernharðsdóttir et al., 2015). Although significant ground shaking occurred in the South Iceland Lowland during these earthquakes, residential buildings had no severe structural damage (Bessason et al., 2016). Damage was mostly non-structural. During the earthquakes in June 2000, many inhabitants found it difficult or even impossible to move to a safe place inside their dwellings (Sigbjörnsson et al., 2018).

Lisbon has 552,700 inhabitants (INE, 2013) distributed in 24 parishes. Many buildings in Lisbon, especially those built before the introduction of the first seismic code in 1958, are seismically vulnerable. Seismic risk is perceived as something distant in Lisbon inhabitants' social memory and has low degree of intrusiveness in their daily lives, in part, due to infrequent damaging earthquakes.

Ferrara is a city of 130,000 inhabitants located in the northern Italy pilot area. It has an urban fabric typical of many ancient Italian cities. It is a UNESCO World Heritage Site. Streets alleys and pedestrian paths date pre-14th century, and Non-Structural- architectural elements of old buildings pose risk to the citizens. Flood hazard has been of most concern to this city in recent years.

The South Iceland Lowland is the largest agricultural region of the country. It contains many small towns and villages as well as critical infrastructure. In comparison to the other pilot-areas, disaster risk management is more integrated in people's routines in this pilot area. Research on perceived and observed residential safety in the aftermath of recent earthquakes (Akason et al., 2006) reveals high risk awareness and knowledge on safety procedures among citizens.

Since the pilot areas differ a lot in terms of both seismicity and socio-cultural aspects, risk

communication needs and methods in these areas had to be diverse. Low intrusiveness of earthquake-related experience in the Portuguese pilot-area required a thorough and longer risk communication protocol, with more encounters between the experts and selected stakeholders. In Italy, the focus was on lessons learned from a city that recently experienced essentially non-structural damage. The focus in Iceland was to communicate the findings and products of the KnowRISK project to selected stakeholders, get their feedback on these products, and to understand their approach on managing risk.

2.2. Stakeholders selection

A stakeholder is any individual, group, organization, institution or network with an interest in the topic being considered. In this work, the stakeholders are classified in four classes, depending on their influence at different level in society, but presumably having diverse interest and needs towards NSE (Table 1).

Table 1: KnowRISK stakeholder's classification according to their presumed interests and needs.

	Schools	**Citizens**	**Business groups**	**Government groups**
Who	Teachers, students, parents	Occupants of residential buildings	Owners, facility and financial managers; professionals	Local government, city council, policy-makers
Interests	To have experts discussing a topic they are not informed about, dialogue and learning.	To have an easy solution to improve their safety.	To protect their assets and costly equipment	To get information, build consensus, make regulations and plan for the community
Needs	Knowledge of solutions in order to suggest actions	Low cost and simple solutions	Technical solutions	Ready solutions

Although government groups can be highly influential in enforcing regulations, citizens and business groups are the core of our society, and schools are where the future of humanity is built.

Schools stakeholders include students, school boards (teachers and head masters) and families. They are interested in knowledge and curricula. They were selected because of their role in building a culture of risk reduction.

Citizens include people of different ages, education, skills and professions. They pay the consequences of vulnerability. They were involved to communicate to what extent NSE risk can be mitigated by laypeople and to learn to what extent they are willing to take actions for mitigation. Information collected from them was used to define tools/protocols of communication campaign and to prepare the Practical Guide.

Business groups included enterprises, owners, facility managers and professionals have mainly a vision of the non-structural risks, in the perspective of minimizing both the disruption period of the activity of the company and of repair costs. Non-structural damages is of great concern to their organization and clients. It is therefore important to understand their opinions, interests and concerns as well as their willingness to take mitigation action.

2.3. Data collection techniques: individual interviews and focus groups

Interviewing methods were different in the three pilot areas. In the Portuguese pilot-area it was important to listen to stakeholders views that were potential users of the Portfolio of Solutions; more precisely, to agents in building industry, as well as owners and operators of critical infrastructures. Earthquake hazard and non-structural seismic risk are difficult topics because the population generally underestimates them. Such underestimation is particularly acute in Portugal where earthquake issue is not of concern

for the general public due to lack of knowledge. To address matter, individual interviewing was adopted instead of group interviewing which would have constraints such as all getting all participants in dialogue at the same time (due to commercial reasons). Individual interviews followed a semi-structured format. It included transmission of information of experts to stakeholders and questions that stimulate the interviewee to express his/her opinion freely.

In the Italian pilot areas, in addition to one-to-one semi-structured interviews, focus groups and checklists were used. Focus group technique is a form of group interview involving several participants and a moderator. It is adopted when there is interest in exploring a particular fairly tightly defined topic (Bryman, in ibid). Focus groups technique was mainly adopted in Ferrara pilot-area with downtown citizens and stakeholders. This area has a recent history of community engagement through group discussions, the so-called *Laboratories*, organized in the aftermath of the 2012 Emilia earthquake sequence. The KnowRISK focus groups were organized according to a pre-established guideline where the moderator introduced the context of the discussion and guided it through a set of topics related to the representation of earthquake damage, awareness towards protection against non-structural damage, residential safety against earthquakes and good practices concerning information about risk. Data collected was recorded, transcript and were subject to the discourse analysis (Manetti and Violi, 1979; Bauer and Gaskell, 2000). The aim was to extract common opinion on specific themes using the most objective approach.

In Iceland pilot-area stakeholders' involvement was organized in a special session of specialized talks from the KnowRISK researchers followed by general talks from various stakeholders including local government, school headmaster, building authorities, and consulting engineers.

3. STAKEHOLDERS AND THE MAKING OF COMMUNICATION TOOLS

The primary goal of interaction with stakeholders is to understand their concern, needs, and obstacles in non-structural seismic risk mitigation. This understanding was crucial to design and implement communication tools. Of these various communication tools, the Practical Guide and the Portfolio of Solutions benefitted the most from the stakeholders.

3.1. Stakeholder contribution in the Practical Guide

Stakeholder involvement in the city of Ferrara provides a good example of contribution to the PG. Twenty-six stakeholders including citizens living in the historic city center as well as business owners and government organizations were involved.

3.1.1. The Ferrara case study

The population in Ferrara was largely unaware of seismic risks until the 2012 Emilia seismic. The memory of historical earthquakes had obviously been lost over the decades and centuries and as a result, seismic hazard had become of less concern than other natural phenomenon such as floods, which are frequent in the area.

It was during the post-event phase of the Emilia sequence that preventative actions started. One of these was the engagement of citizens in discussions on how prevention could be implemented by efforts that each actor (citizen, professionals, municipalities and scientists) could undertake, promote or communicate. The framework of these discussions was the so-called "Laboratories for the prevention of the seismic damage" campaign, hereafter referred to as *Laboratories*. The result was a leaflet ("10 good practices to make our home safer") with safety guidelines. Need to implement strong communication and social cohesion actions by the public administration was formally documented by the City Council and approved by its members.

The "10 good habits" leaflet (Figure 1) was edited as a shared document that took into account interests, needs, priorities and obstacles expressed by stakeholders involved in the *Laboratories*. On top of the list there is the recommendation to gather information about the soil type, interventions that were carried out on a building after its construction and on damage caused by the last earthquake. Most of the remaining suggestions were related to NSE measures.

10 GOOD HABITS TO MAKE OUR HOME SAFER

1. KNOWLEDGE FIRST OF ALL: the subsurface of your house, what interventions on building over the years and damage caused by the last earthquake

2. *NOT ALONE*: Actions for prevention must take into adjacent buildings into account

3. SOME MINIMUM INTERVENTION: furniture anchorage, heavy objects on lower shelves, secured false ceilings, choose to place light furniture in attics

4. UNBURDEN ATTICS: avoid storage of heavy and unnecessary objects in attics

5. CARE FOR ROOF MAINTENANCE: tiles may fall; they may only just move and cause water seepage that will weaken the beams and make them vulnerable to ground shaking

6. SECURE CHIMNEYS AND EVES: chimneys, eves, balconies, ornaments are vulnerable to fall and should be secured

7. CHECK GUTTERS: leaking gutter may damage to wall and increase seismic vulnerability

8. CHECK DRAINAGE AND WATERSPOUT: moisture may damage foundation

9. REMEMBERING THAT.... expert knowledge is important to access vulnerability

10. FINALLY, FIND A SAFE PLACE IN YOUR HOME- don't run away, unless you may quickly get to a safe open space; find a safe place in your house (e.g. a load bearing beam), make sure that exits doors are not blocked by furniture that may topple; have a sturdy table under which you may drop, cover and hold on.

Figure 1. The "10 good habits" leaflet (Left) and its tentative translation to English (right).

Our objective was to understand if, five years after its introduction, the suggestions of the Leaflet had been implement, and what obstacles, if any, were encountered during their implementation. For this task, two different groups of citizens living in the city center who had felt the 2012 earthquake sequence were consulted. The first group included those who took part in the preparation of the "10 good habits" leaflet, knew and likely remembered the issues addressed during the *Laboratories*. The second group did not participate to the preparation of the leaflet. Each group had good representation in terms of age, gender, education, and profession. Focus groups were organized and the data was analyzed to understand if and how prevention was undertaken and how this can be addressed in the KnowRISK Practical Guide. They followed a well-defined structure with four major sessions: (1) ideas and opinions about seismic damage prevention (lasting about 15 min); (2) prevention of non-structural damage (lasting about 30 min); (3) best practices to communicate prevention (lasting about 40 min); (4) how to disseminate best practices (lasting about 15 min). Keywords expressed by the participants were important to derive shared and frequent issues. Table 2 is an example of keywords used during the first phase of focus groups.

Table 2. An example of focus groups data. Words related to Seismic Damage (session 1); citizens who took part in the preparation of the "10 good habits" leaflet (left) and those who did not take part (right).

Citizens group 1	Citizens group 2
The structure of my house	We are all scared
People's life	Solidarity
Danger to be isolated	Insurance
Psychological damage	Destruction
Human relationships	Quality of buildings
Solidarity	Information
Mourning	Competences of disaster managers
	Prevention
	Organized/disorganized, chaos
	Robbery
	Election campaign
	Frequency
	Funds
	Possible
	Unpredictable
	Job
	Civil protection

In addition, 12 stakeholders (age 44-65 years old) that were influential at different level on the issue of seismic prevention were interviewed. They represent a broad range of institutions and disciplines: university (engineers, geologists, historians, architects); Municipality (civil protection representatives, councilors for urban development and infrastructures, communicators); Civil Society Organizations (cultural heritage, urban renewal, social instances); professional associations (geologists, engineers).

3.1.2 Results from analysis

The data collected in Ferrara was processed using the qualitative software package called Atlas-ti (Paulus et al., 2015) that is capable of thematic discourse analysis (Manetti and Violi, 1979; Bauer and Gaskell, 2000). A snapshot transcription of the discourse is presented in Musacchio et al., 2017.

Results considered useful for the PG are summarized below.

1. **Memory:** Recollection of the earthquake and most relevant elements of the story telling.

In Ferrara, where physical damage was the main consequence of the earthquake and no loss of human life occurred, people tend to remember damages to NSE. However, data underline that the memory of the earthquake gets easily lost, even among experts.

2. **Knowledge:** Meaning of seismic damage, knowledge/relevance of the distinction between structural and non-structural elements.

Despite the recent experience of damage to NSE, there seems to be very little distinction or understanding of the difference between structural and non-structural damage. Even when experienced damages were non-structural, citizens' priority seems to be structural safety.

3. **Prevention:** Definition, measures, needs, obstacles, enforcement and controls.

Major needs are focus on safety, adequate information, regular training, and enforcement of regulations.

Four major obstacles towards the implementation of preventative actions were identified: the fatalist attitude, lack of knowledge on proper actions, the need to have experts for intervention, the perception of seismic risk as an unlikely future event. A major problem is that citizens tend to ascribe the preventive action to others, in particular the local administrations, the civil protection, and the scientific community. In the words of one of the participants "The culture of delegating prevails, taking away the sense of responsibility".

4. **Communication:** Efficacy of the leaflet, obstacles in communication, contents and media for efficient prevention, the role of experts.

Only five years after the earthquake sequence, the "10 good habits" leaflet and its recommendation for NSE reduction, seem to have been forgotten. For the failure citizens blamed poor dissemination and recommended: (1) better involvement of key stakeholders (i.e. buildings administrators, schools) who can act as hubs for distribution among citizens, (2) a monitoring phase of the real implementation and the level of autonomy developed by the citizens, and (3) a more focused dissemination during other engagement events in town (i.e. festivals, science cafés). A critical issue concerns the identification of experts and their roles. The laypeople consider as experts, not only scientists and engineers, but also technicians from different field (maintenance staff, installers) without a clear distinction. This poses a serious problem, as laypeople are not sure which experts to consult for different actions.

3.1.3 Application to the making of the Practical Guide

The key issues identified above were taken into account in preparing the Practical Guide (PG). The lack of knowledge about NSE, the need for support, the attitude to delegate action to others, and the need for identification of proper experts were addressed in various ways in the PG. The contents of the PG were categorized in such a way that citizens would, while understanding the meaning, find a real help on how to do it (support), how costly it is and on which element intervention is more relevant (knowledge). The PG was organized as a path to improve safety with steps that went from just moving loose objects, protecting valuables, securing what could not be moved to retrofitting architectural components and utilities (Figure 2). The actions along the mitigation path increase progressively in terms of required

time, funds, and expert knowledge, thus helping the citizens to take immediate actions where possible and plan actions that are more complex or costly.

The PG was disseminated during special events when KnowRISK team interacted with the public, but schools were also used as hubs for distribution.

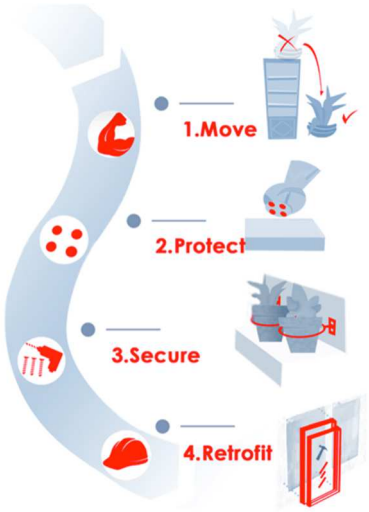


Figure 2: Conceptual path to risk mitigation followed in KnowRISK Practical Guide (Ferreira et al., 2018)

3.2. Stakeholders contribution to the Portfolio of Solutions

Research on interests, needs, priorities, and obstacles of stakeholders provided valuable input to the preparation of the KnowRISK Portfolio of Solutions. This research was mostly carried out in the Lisbon pilot area. The stakeholders included owners and operators of infrastructures and services such as electricity, water, communications, transportation, food distribution, and commerce. Other stakeholders were the Alvalade and Olivais Parish Councils, representing local authorities.

The stakeholders were selected due to the importance of the goods and services they provide and the impact that a serious disruption affecting them can cause to the functioning of the country. Non-structural risks can pose a threat to the entire organization and their customers, should an earthquake occur. The KnowRISK project wanted to assess their awareness, interests and concerns on this topic, as well as to learn whether they were willing and able to start taking actions. Representative from 12 organizations, namely CP Comboios de Portugal, CTT Correios de Portugal, EDP - Energias de Portugal, EPAL - Grupo Águas de Portugal, IKEA Portugal, Infraestruturas de Portugal, Jerónimo Martins, Metropolitano de Lisboa, NOS communications and entertainment group, PT-Altice, Siemens and SONAE MC, were involved.

The interaction took place during several meetings, with 1-6 representatives of each of these organizations with different fields or expertise. The meetings were in-person interviews, of one hour duration. The KnowRISK project and its product such as the PG and Move Protect and Secure video campaign (Ferreira et al., 2018) were discussed with the stakeholders. The KowRISK researchers visited some facilities of these organizations and identified vulnerabilities and good practices. For each meeting a roadmap was prepared according to the topics that each stakeholder would probably be more interested in. Relevance was assigned to a List of NSE classified with a hierarchy based on a Cost-Benefit-Approach (CBA). This approach is discussed in more detail in the following sections. Potential losses and business interruption due to non-structural damage was discussed. Mitigation measures and good practices to improve the seismic performance of NSE, using a working version of the KnowRISK Portfolio of Solutions, were discussed.

In general, owners and facility managers care very much about their facilities and equipment but they did not give value to the opportunity to present themselves as the benchmark in safety measures (“earthquake-proof“ slogan or stamp). In some cases they simply inform their employees by internal channels of communication. However, organizations that give more importance to people's safety are

those who have a large concentration of individuals (clients and employees) or must ensure that the service is guaranteed 24h/24h (e.g. super- and hypermarkets, call centers).

3.2.1 KnowRISK Portfolio of Solutions: basic philosophy

The Portfolio of Solutions is based on a rational classification of NSE elements, which considers performance and consequences of damage. This is necessary to identify the hierarchy of importance of NSE elements and their presence in the Portfolio of Solutions. Information from several sources (FEMA 2005, 2012, Porter et al., 2014, including stakeholders opinions, etc.) were collected and a list of 120 NSE was compiled. Each of the NSE was then ranked in terms of their relevance in categories such as Life Safety, Property Loss, Functional Loss, Expertise needed for risk mitigation, and potential financial cost of mitigation. Level of expertise was classified as DYI (Do It Yourself), non-engineered solution implemented by a tradesman, and engineered solution. A CBA was performed (Philips and Bana e Costa, 2007) to rank mitigation actions, considering 'cost of intervention' and 'impact on risk reduction'. This helped in ranking risk mitigation of NSE in residential buildings, workplaces and classrooms: the 47 most important NSE elements were included in the Portfolio of Solutions. The hierarchy of each NSE is clearly marked in the portfolio (see Figure 3).

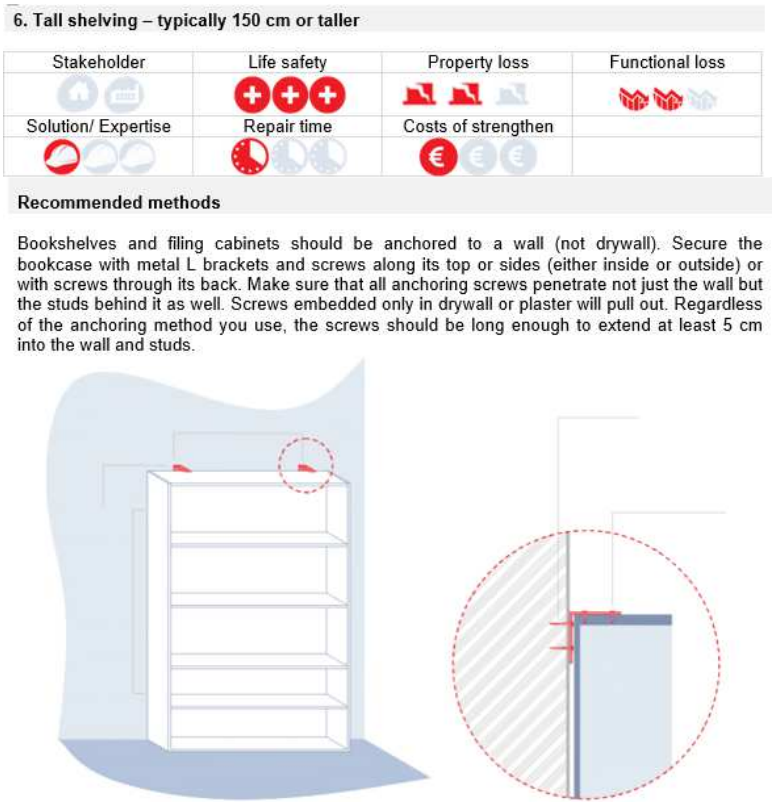


Figure 3. KnowRISK Portfolio of Solutions layout.

3.2.2 Input from stakeholders' engagement

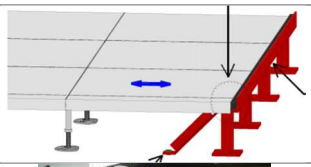
Priorities of interventions vary according to the stakeholders needs. Some stakeholders have already their own "Portfolio" of best practices for the main elements (structural and non-structural) they consider critical for business/service continuity.

Energy providers and public transportation companies (e.g. EDP and Metro, in Portugal) particularly emphasized concerns about the installation, attachment, and inspection of non-structural components in their facilities. Two of them identified the most vulnerable NSE in their facilities. Considering the information provided about the costs/benefits of risk mitigation, they developed technical solutions and guidelines for risk management. An example is shown in Figure 4. The CBA procedure used to rank urgency of mitigation may need to be adapted to stakeholder criteria, objectives, and values. Stakeholder

priorities were systematically collected in a checklist. Stakeholders (association of engineers in Sicily, Italy, and the 12 companies in Portugal) were asked to rank the NSE included in the portfolio.

ACCESS FLOORS FOR CRITICAL FACILITIES

Raised floors must be capable of withstanding lateral loads. The number of diagonal braces should be one floor tile length around the perimeter of the equipment footprint, for equipment less than 300 kg weight.



DESKTOP COMPUTER EQUIPMENT

Fix monitor to the wall or to the desk.

Figure 4. Contributions to the KnowRISK portfolio of solutions given after meetings with Metro (top) and EDP (bottom) in Lisbon.

Figure 5 shows a part of the list of 47 NSE ranked by the stakeholders in Italy and Portugal. The priorities are ranked as High (H), Medium (M) or Low (L). The 'KnowRISK Priority ex-ante' is based on CBA. The results show that different stakeholders have different priorities. For example, engineers (Italian case study) are more concerned with Life safety, but assign Medium priority of intervention to non-life-threatening elements such as 'large computers equipment, data centers, computer rooms'. The stakeholders from Portugal, being owners and operators of businesses and critical services, assign high priorities to these elements. Physical damage to servers and IT equipment will likely result in loss of business and serious disruption of public services, as correctly identified by the stakeholders. The same reasoning applies to computer access floors. It is important for business owners and operators but not for homeowners and schools.

No.	NSE Class	KnowRISK Priority ex-ante	Stakeholder Priority (Italy)	Stakeholder Priority (Portugal)
1	Heavy flat-screen TV and panels monitor walls	H	H	H
2	Hazardous materials storage such as chemicals (labs, pharmacies, schools)	H	H	-
3	Large computer equipment, data centers, computer rooms	H	M	H
4	Fire extinguisher and cabinet	H	H	H
5	Air diffusers	H	M	H
6	Tall shelving – typically 150 cm or taller	H	H	H
7	Tall file cabinets and furniture	H	H	H
8	Heavy light fixtures	H	M	H
...	.....	...	...	...
47	Computer access floors and equipment	M	M	H

Figure 5. Ranking of the NSE priority (only a few shown here) by stakeholders in Italy (association of engineers of Sicily) and Portugal (NOS communications and entertainment group, Metro and EDP). (H= High; M=Medium; L=Low).

As part of internal dissemination, most stakeholders decided to use internal channels (screens in common areas, webpage, newsletters, etc.) to convey the information to most personal and to intensify the collaboration with the follow up of KnowRISK. In general, meetings were very productive and all stakeholders have asked to have access to the Portfolio of Solutions, either in e-format or paper. The KnowRISK project gained feedback, refine approach and through this process create more focused recommendations.

3.3. Interaction with stakeholders in Iceland

Stakeholder engagement in Italy and Portugal provided vital input to the PG and Portfolio of Solutions. In Iceland, the focus was to share these products with the stakeholders and get their feedback on the products. With this objective, interaction with stakeholders was organized. At the time these products

were tentatively ready, but not finalized. Interaction with the stakeholders in Iceland was conducted during a special session of the International Conference on Earthquake Engineering and Structural Dynamics (ICESD) held in Reykjavik on 12-14 June 2017. Six stakeholders participated in the session: the Mayor of Hveragerði, a town damaged by the May 2008 earthquake, a representative of Icelandic Standards (IST), a representative of Icelandic Construction Authority, a consulting civil engineer, and the headmaster of the school in Selfoss where the KnowRISK intervention was carried out. The Mayor of Hveragerði emphasized the need to secure building contents, and pointed out the need to have arrangements in furniture doors so that they do not open during earthquakes. It was also pointed out that tables with wheels were hazardous, and that common partition wall materials in Iceland are not suitable to hold heavy hanging objects. These concerns were addressed in the Portfolio of Solutions, which was still in preparation. The interaction was also important to convey the results of the project to other stakeholders and to motivate authorities such as IST and Icelandic Construction Authority in mitigation of non-structural risk.

4. FINAL REMARKS

The analysis of interests, needs, obstacles, and priorities of citizens and stakeholders from the public and private sector provided a rational basis for the communication campaign and products of the KnowRISK project, in particular the Practical Guide (PG) and Portfolio of Solutions. Stakeholder engagement for this purpose was achieved in different ways in the three pilot areas.

Qualitative interviewing and focus groups were, however, the main mode of engagement. Individual semi-structured interviews were used in Portugal. Individual interviews and focus groups were used in Italy. Data collected from stakeholders in Italy was qualitatively analyzed using thematic discourse analysis methods. Data collected in Portugal was used to validate and supplement ranking of NSE in terms of priorities for intervention, carried out ex ante through a cost benefit analysis. The collected data and results were very useful in designing and preparing two very important products of KnowRISK project, the Practical Guide and the Portfolio of Solutions. Interaction with stakeholders in Iceland provided valuable input to improve the Portfolio of Solutions, and confirmed the suitability of the PG in this study area.

The main premise of this KnowRISK action and the work presented here is the importance of tailoring communication to the needs of the audience. Risk communication can be made more effective by understanding the local social context, past experiences, needs, concerns, and awareness of the parties facing risk. Local community and private sector stakeholders are relevant parties on risk reduction process. If they are involved in the process of designing communication tools, they are more likely to maintain a positive attitude towards the tools. Some stakeholders such as business and service providers have specific needs and concerns and their priorities differ by the nature of facilities operated by them. They can provide valuable information on current and best safety practices, including technical solutions to mitigate risk. The experience from this work suggests that development of communication tools by engaging the stakeholders is not only feasible but also rewarding, in terms of both the quality and usefulness of the final products.

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6. REFERENCES

Akason JB, Olafsson S, Sigbjornsson R (2006). Phases of Earthquake Experience: A Case Study of the June 2000 South Iceland Earthquakes. Risk Analysis 26(5):1235-46. DOI10.1111/j.1539-6924.2006.00811.x.

Bauer M, Gaskell G (2000). Qualitative Researching with Text, Image and Sound. A Practical Handbook, Sage, London.

Bernharðsdóttir AE, Musacchio G, Ferreira MA, Falsaperla S (2015). Informal Education for Disaster Risk Reduction. *Bulletin of Earthquake Engineering*, DOI:1007/s10518-015-9771-9.

Bruine de Bruin W, Bostrom A (2012). Assessing what to address in science communication. *Proceedings of the National Academy of Sciences of the United States of America*, 110(3): 14062–14068.

Bessason B, Bjarnason JÖ (2016). Seismic vulnerability of low-rise residential buildings based on damage data from three earthquakes (Mw6.5, 6.5 and 6.3), *Engineering Structures*, 111:64–79.

Bryman A (2004). Social Research Methods. Oxford: Oxford University Press.

FEMA 74-FM (2005). Earthquake hazard mitigation for non-structural elements. Field Manual. Federal Emergency Management Agency (FEMA), Washington.

FEMA E-74 (2012). Reducing the Risks of Non-structural Earthquake Damage – A Practical Guide, Federal Emergency Management Agency (FEMA), Washington.

Ferreira MA, Solarino S, Musacchio G, Mota de Sá F, Oliveira CS, Lopes M, O'Neill H, Orlando L, Faggioli MM (2018). KnowRISK tools for preparedness and community resilience: Practical Guide, Short Guide for Students, Portfolio and Video, *Proceedings of the 16th European Conference on Earthquake Engineering*, 18-21 June 2018, Thessaloniki, Greece.

Instituto Nacional de Estatistica (INE) (2013). O Parque Habitacional e a sua Reabilitação: Análise e Evolução 2001-2011. Lisboa: INE.

Morgan MG, Fischhoff B, Bostrom A, Atman CJ (2002). Risk Communication: A Mental Models Approach Cambridge University Press, Cambridge, United Kingdom.

Musacchio G, Falsaperla S, Piangiamore GL, Solarino S, Crescimbene M, Pino NA, Eva E, Manzoli F, Butturi M, Fabbri M, Accardo M (2017). KnowRISK on Seismic Risk Communication: the set-up of a participatory strategy. In: *Proceedings of the International Conference on Earthquake Engineering and Structural Dynamics*, 12-14 June 2017, Reykjavik, Iceland.

Musacchio G, Silva DS, Ferreira MA, Falsaperla S, Piangiamore GL, Eva E, Solarino S, Reitano D, Rupakhety R, Oliveira CS, Lopes M, Vicente M, Olafsson S, Bjarni B (2018). Seismic risk communication to schools, citizens and professionals: the KnowRISK approach, *Proceedings of the 16th European Conference on Earthquake Engineering*, 18-21 June 2018, Thessaloniki, Greece.

Paulus TM, Lester JN, Dempster PG (2015). Digital Tools for Qualitative Research, DOI: http://dx.doi.org/10.4135/9781473957671.

Piangiamore GL, Eva E, Musacchio G (2017). The participatory risk communication action of the KnowRISK project: Italy, *Proceedings of the International Conference on Earthquake Engineering and Structural Dynamics*, 12-14 June 2017, Reykjavik, Iceland.

Platt S, Musacchio G, Silva DS, Crescimbene M, Pino N, Ferreira MA, Oliveira CS, Lopes M, Rupakhety R, (2018). Assessing the effectiveness of risk communication in Europe, *Proceedings of the 16th European Conference on Earthquake Engineering*, 18-21 June 2018, Thessaloniki, Greece.

Porter K, Farokhnia K, Vamvatsikos D, Cho IH (2014). Guidelines For component-based analytical vulnerability assessment of buildings and non-structural elements, GEM Technical Report 2014-13 V1.0.0, 102 pp., GEM Foundation, Pavia, Italy, doi:10.13117/GEM.VULN-MOD.TR2014.

Sigbjörnsson R, Ragnarsdóttir S, Rupakhety R (2018). Is perception of earthquake effects gender dependent? In Rupakhety and Olafsson (eds), *Earthquake Engineering and Structural Dynamics in memory of Ragnar Sigbjörnsson*, Geotechnical, Geological, and Earthquake Engineering 44, DOI 10.1007/978-3-319-62099-2_18.

Silva, D.S, Pereira, A., (2017), Vicente, M., Bernardo, Ferreira M. A., Oliveira C.S. (2017). Seismic risk communication: how to assess it?, *Proceedings of the International Conference on Earthquake Engineering and Structural Dynamics*, 12-14 June 2017, Reykjavik, Iceland.

Violi P, Manetti G (1979). L'analisi del discorso, Roma, Espresso Strumenti.